1. **Dataset Title –** NOAA Microwave Radiometer Data and Thermodynamic Profile Retrievals
2. **Dataset Author(s) –** Bianca Adler (corresponding author for the thermodynamic profile retrievals: bianca.adler@noaa.gov) and Laura Bianco (corresponding author for the MWR data: laura.bianco@noaa.gov).
   Others: James Duncan, Dave Turner, James Wilczak.
3. **Time of Interest –** Lakeland (WI) site: Begin date: 2019/08/01 12:08:58 AM;
   End date: 2019/10/29 4:20:38 PM.
   Prentice (WI) site: Begin date: 2019/07/31 12:07:43 AM;
   End date: 2019/09/18 7:27:57 PM.
   Tall Tower | ISS (WI) site: Begin date: 2019/09/18 10:15:17 PM;
   End date: 2019/10/13 2:20:38 PM.
4. **Area of Interest –** Lakeland (WI) site: Lat: 45.924593; Lon: -89.727199. Prentice (WI) site: Lat: 45.5391; Lon: -90.2803. Tall Tower | ISS site: (WI) Lat: 45.9455; Lon: -90.2935.
5. **Data Frequency –** Frequency of data collection: MWR: ~2-3 minutes; Thermodynamic Retrievals: 10 minutes
6. **Data Spatial Type –** ISO metadata Spatial Representation: text Table.
7. **Version:** This is version 3.0 of the thermodynamic retrieval data set (created in June 2021). Due to an error in the processing the surface met station was not used in the retrievals in version 2.0 (created in October 2020).
8. **General Dataset Description –**
   NOAA Microwave Radiometer Data Description
   Two Radiometrics MP-3000A MWRs were deployed during the CHEESEHEAD experiments. The thermodynamic microwave radiometer profilers continuously observe air temperature, humidity and liquid features that define local weather. These two MWRs have 21 K-band (22 to 30 GHz) channels, and 14 V-band (51 to 59 GHz) channels. All output files are named automatically using the following format: yyyy-mm-dd_hh-mm-ss_xxx.csv, where yyyy is the year when the file was started, mm is the month of the year, dd is the day of the month, hh is the hour of the day, mm is the minute of the hour, ss is the second of the minute, and xxx defines the output file type as follows:

   - xxx=lv0 level0 file
   - xxx=lv1 level1 file

   All output files contain a sequential record number in the first field, starting with the number 1. All output files contain a date/time stamp in the second field of all records that contain time-dependent data.

   lv0 files contain raw, unprocessed data in engineering units. lv0 files contain 100 percent of the information needed to reprocess the raw data with alternative calibration information or algorithms.

   lv1 files contain real-time brightness temperatures (TB) for each channel specified in the configuration file. Real-time level1 files are produced from contemporaneous level0 data and calibration information in the configuration file.

lv2 files (not computed) contain records of real-time retrievals of temperature, water vapor, relative humidity, and liquid water profiles. Typically, the retrievals would be produced using the contemporaneous level1 data and the neural network files specified in the configuration file. Instead of using the neural network to resolve these vertical profiles, retrievals are constructed using an optimal estimation-based physical retrieval algorithm.

Microwave radiometers (MWRs) must be calibrated periodically, both for the K-band and V-band. The calibration is needed to convert measured voltages/counts into brightness temperatures (TB). Two types of calibrations are possible: the liquid nitrogen (LN2), or cold target one, and tipping curve calibration (TCC). All microwave channels (K-band and V-band) can be calibrated using LN2 as a cold absolute standard. The disadvantage of the LN2 calibration is that it requires several people onsite to perform. Conversely, the advantage of a TCC is that it can be performed remotely. However, a successful TCC requires a non-optically thick atmosphere at the frequency at stake. At approximately sea level, only K-band channels are transparent enough to be calibrated via this method. For this reason, LN2 calibration was performed at deployment for the Prentice site, while at the Lakeland site it was unfortunately not successful. TCC calibrations have also been performed after the deployment.

Retrieved Thermodynamic Profile Data Description

An optimal estimation physical retrieval algorithm TROPoe was used to construct vertical profiles of temperature (C) and the water vapor mixing ratio (g kg^{-1}). Please reference Turner and Löhnert (2014) and Turner and Blumberg (2019) for more information on the employed optimal estimation physical retrieval algorithm.

Turner, D. D., and U. Löhnert, 2014: Information content and uncertainties in thermodynamic profiles and liquid cloud properties retrieved from the ground-based Atmospheric Emitted Radiance Interferometer (AERI). *J. Appl. Meteor. Clim.*, **53**, 752-771. https://doi.org.10.1175/JAMC-D-13-0126.1

D. D. Turner and W. G. Blumberg, 2019: Improvements to the AERIoe Thermodynamic Profile Retrieval Algorithm. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 12, no. 5, pp. 1339-1354. https://doi.org.10.1109/JSTARS.2018.2874968

Retrievals were constructed at a 10-min temporal resolution using different data input sources to examine the impact of added information content on the retrieved thermodynamic profiles. The NOAA MWR at Lakeland, Prentice, and the Tall Tower (WLEF) | ISS site measures microwave radiation at the zenith (i.e. 90.0°) and at distinct oblique elevation angles (19.8° and 160.2°). Retrievals were constructed using the collocated surface meteorology data (provided by PSL at Lakeland and Prentice and provided by NCAR at the Tall Tower | ISS site) and using
(1) only the MWR zenith data and surface data
(2) MWR zenith and oblique data and surface data.

(3) MWR zenith and oblique data, surface data and Radio Acoustic Sounding System (RASS) virtual temperature data. At the Lakeland and Prentice sites, a 915 MHz Radar Wind Profiler (RWP) was deployed along with a RASS to measure vertical profiles of virtual temperature, while at the Tall Tower | ISS facility a Sodar RASS was deployed to record these measurements.
(4) MWR zenith and oblique and thermodynamic profiles from Rapid Refresh model – RAP, Benjamin et al. 2016 – above 4 km above ground level.

Benjamin, S. G., S. S. Weygandt, J. M. Brown, M. Hu, C. R. Alexander, T. G. Smirnova, J. B. Olson, E. P. James, D. C. Dowell, G. A. Grell, H. Lin, S. E. Peckham, T. L. Smith, W. R. Moninger, J. S. Kenyon, and G. S. Manikin, 2016: A North American hourly assimilation and model forecast cycle: the Rapid Refresh, Mon. Wea. Rev., 144, 1669–1694, https://doi.org/10.1175/MWR-D-15-0242.1175/MWR-D-15-0242.1.

These three data input groupings are denoted by the names:
(1) zenith-only input (z)
(2) zenith plus oblique input (zo)
(3) zenith plus oblique plus RASS input (zo_rass)
(4) zenith plus oblique plus RAP input (zo_rap)

The output of the optimal estimation-based physical retrieval algorithm using these different data input groups are saved using the following format:

site_name.data_input group.yyyymmdd.cdf

These file name variables are defined below.

- *site_name*: *arv* denotes the Lakeland site, *prw* denotes the Prentice site, and *iss* denotes the Tall Tower | ISS site.
- *data_input_group*: *z, zo, zo_rass, and zo_rap*
- *yyyymmdd*: *yyyy* denotes the year with century as a decimal number, *mm* denotes the month as a zero-padded decimal number, and *dd* denotes the day of the month as a zero-padded decimal number.

The configuration (so called vip) files used to run TROPoe are stored for each site and each group using the format:

vip.site_name.data_input group.txt

The expert user can find information on bias correction and uncertainty of the MWR brightness temperatures, etc in these files.

There are several variables included in the retrieval data files that give an indication of the quality of the retrieved thermodynamic profile. These variables include (but are not limited to):

- *rmsa*: root mean square error between the observation vector and the forward calculation
- *rmsr*: root mean square error between the brightness temperatures in the observation vector and the forward calculation

The retrieved thermodynamic profiles at each site were compared to radiosonde data released from the Tall Tower | ISS site, and the ability of the retrieval to resolve the radiosonde measured thermodynamic profile was examined as a function of both the *rmsa* and *rmsr* variables. This analysis indicate that either variable can be used as a robust quality control measure. A *rmsr*|*rmsa* filter of ~ 2.3 (i.e. neglecting thermodynamic profiles whose *rmsr*|*rmsa* value falls above this filter) appears to remove a significant amount of the noise in the retrieved thermodynamic profiles. However, the authors encourage data users to independently examine this filter as useful thermodynamic information—depending on the intended use of the data—can be found in retrieved profiles whose *rmsa*|*rmsr* value exceeds the aforementioned threshold.

Note for the Lakeland site: Investigation of the MWR brightness temperatures revealed some unrealistic jumps during the campaign period for some channels. The affected channels (22, 22.234, 22.5, 29.5, 30.0, 57.288 GHz) were excluded from the retrievals. A glitch in the data acquisition system prevented the retrieval on several days, namely 5 Aug, 14 Aug, 21 Aug, 2 Sep, 15 Sep, 17 Sep, 20 Sep, 23 Sep, 25 Sep, 11 Oct.

9. **File Names** –

NOAA MWR File Information

At each site, files are zipped together into three site-specific files: 'MWR_Lakeland_WI.zip'; 'MWR_Prentice_WI.zip', 'MWR_TallTower_WI.zip'. At each site the list names of files being transferred is: yyyy-mm-dd_hh-mm-ss_xxx.csv, where yyyy is the year when the file was started, mm is the month of the year, dd is the day of the month, hh is the hour of the day, mm is the minute of the hour, ss is the second of the minute, and xxx defines the output file type as follows:

- xxx=lv0 level 0 file
- xxx=lv1 level1 file

Retrieved Thermodynamic Profile File Information

Similar to the NOAA MWR files, the output of the optimal estimation physical retrieval algorithm and the respective vip files are zipped together into three site-specific files: 'TROPOE_Lakeland_WI.zip', 'TROPOE_Prentice_WI.zip', 'TROPOE_ISS_WI.zip'.

The data in the station-specific zip file (named according to *site_name.data_input type.yyyymmdd.cdf*) encompass the following data periods.

- Lakeland: 1 August through 29 October
- Prentice: 1 August through 18 September

- ISS: 18 September through 12 October

10. **Data restrictions –** N/A.
11. **GCMD Keywords** – Earth Science - Atmosphere – Atmospheric Temperature
    Earth Science - Atmosphere – Humidity
12. **Publications** – N/A.